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United States Department of the Interior

GEOLOGICAL SURVEY
EROS Data Center
Sioux Falls, South Dakota 57198

IN REPLY REFER TO: OAB7-12

July 3, 1984

Memorandum

To: Technical Officer

From: Principal Investigator AN 31

Subject: Quarterly Report: Landsat 4 Investigations of Thematic Mapper and Multispectral Scanner Applications (PCN902-91548; S-10757-C)

1) Problems

No problems occurred this quarter.

2) Accomplishments

a) The experimental objective using the TIPS TM North Dakota data was to suppress interband detector noise as discussed by TM investigators (Wrigley 1982 and Malila & Metzler 1984). According to Wrigley (1983) high frequency noise components exist in band 1 - 4 of the TM. In our TM analysis, which only involves bands 2, 3 and 4, two scenes were extracted from the data set. The first scene was a homogeneous water area (128 x 128 pixels). The second was an agricultural scene (512 x 512 pixels). In accordance with Wrigley (1983), peaks are evident at line 81 in the magnitude image of the fourier transform. Similar peaks are seen in line 40 of the homogeneous water area as well as along line 1 in both fourier transforms. Band 2 of the homogeneous water area was processed with a 3 x 3 median filter, and a fourier transform was applied using this output image. The magnitude image of the transform does not have peaks along line 40, and there is also a reduction in intensities of the peaks along line 1.

When a different image was created by subtracting the median image from the original image, the locations of changes made by the median filter corresponded to locations of changes in the original where detector offsets were evident. Originally, when the agriclutural scene was displayed and all three bands flickered, a smear was seen in band 2. Median filters are often used to eliminate this type of image degradation (Narenda 1981), and so median filter preprocessing was tested using the homogeneous water area. As improvements were visually evident, the same technique was applied to the agricultural area. A high pass filter (Hall and Autrey 1983) was applied to the

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median filter output and also to the original. Since the peaks in the fourier transform corresponded to high frequency, it is expected that the output image from the high pass filter of the original will have enhanced the noise. On the other hand, this will not be the case in the prelow pass filtered output. As expected, while the original image with just high pass filtering applied looked sharper than the median high pass image, noise was evident and detracted from the overall image quality. It is also possible that a different high pass filter exists which can create a sharper picture.

In conclusion, TM has high frequency noise components which can be suppressed by median filtering. This is advantageous to users who are unfamiliar with the frequency domain and who intend to perform some type of high pass filtering.

b) As a part of the NASA Landsat D Image Data Quality Analysis Program, the EROS Data Center developed procedures to optimize the visual information content of thematic mapper data and evaluate the resulting photographic products by visual interpretation. The conversion of digital values acquired by Landsat satellites to photographic images requires transfer functions which incorporate the effects of data variability, film response curves, and laser beam recorder response characteristics. Data variability differences between MSS and TM data required the design of different transfer functions for each of the two data sources. A digital-to-analog TM transfer function was developed which would properly place the digital values on the most useable portion of a film response curve. Utilizing the calculated minimum, mean, and maximum and the respective standard deviations of the bands from 50 sample scenes of TM data, look-up tables were designed which resulted in acceptable photographic products. Evaluation of these products was accomplished by generation of color composites of selected band combinations using standard photo production procedures, and visual interpretation of scene features.

Interpreter evaluation of the selected band combinations indicated that the transfer functions produced interpretable color-composite images using standard photographic procedures. Four experienced photo interpreters ranked 2 cm diameter chips of selected image features of each band combination for ease of interpretability. A nonparametric rank-order test determined the significance of interpreter preference for the band combinations. In addition, the consistency of interpretation among features from two scenes of different regions of the United States indicates the ability of the transfer functions to accommodate radiance value differences among scenes. Although the scenes generated using fixed transfer functions were not as aesthetically pleasing as custom-made products, the color renditions were entirely acceptable.

3) Significant Results

Easily interpretable color-composite TM data can be generated through use of various band combinations with proper TM transfer functions.

4) Publications

McCord, J. R., Binnie, D. R., and Seevers, P. M., Digital to Analog Conversion and Visual Evaluation of Thematic Mapper Data, Sioux Falls, South Dakota, 1984, (in USGS review).

5) Recommendations

None.

6) Data Utility

None.

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